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Vitamin B-12 Supplements *for growing and* fattening pigs

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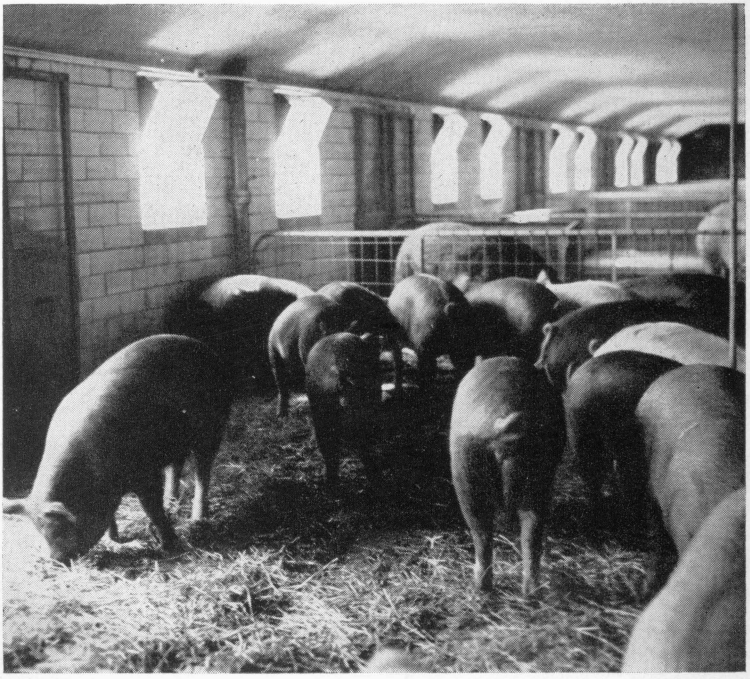

Ohio Agricultural Experiment Station
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CONTENTS

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VITAMIN B-12 SUPPLEMENTS FOR GROWING AND FATTENING PIGS

W. L. ROBISON

INTRODUCTION

In experiments reported in Ohio Agricultural Experiment Station Bulletin 699 (13), soybean oil meal was shown to be a satisfactory protein concentrate for feeding with corn and minerals to pigs on good pasture. On the other hand, there were serious objections to it when it was fed with corn, 5 percent of good quality ground alfalfa, minerals, and irradiated yeast to pigs in dry lot.

In the dry lot experiments, some of the pigs failed to make normal muscular and skeletal development. Some became excessively fat. Some became wrinkly and rough in the skin. A number developed a wheezy respiration. These could stand little exertion. Some of them died when attempts were made to drive them a short distance, as for weighing. The wheezy condition was not encountered in all of the tests. Rather than continuing to gain at an increasingly rapid rate, as is typical of pigs that are thriving, a number reached a point at which they ceased to gain or began losing weight. Removals, because the pigs were doing poorly, amounted to 4.2 percent in the case of pigs fed a mixture of tankage and linseed meal, and to 13.6 percent in the case of pigs fed soybean oil meal as the protein concentrate.

For feeding with animal protein concentrates, soybean oil meal was as effective as linseed meal. Obviously when soybean oil meal was fed as the only protein concentrate the rations were deficient in some nutritional factor or factors that was supplied by animal protein feeds. Experiments by others gave similar results. Since the factor was present in such feeds as liver or glandular meal, fish meal, milk products, meat scraps, and tankage it was sometimes designated by the term "animal protein factor" or by the abbreviation APF.

In an attempt to provide a satisfactory dry lot ration containing soybean oil meal or a high-protein feed of plant origin as the only protein concentrate, various materials were fed with corn, soybean oil meal, ground alfalfa, minerals and irradiated yeast.

The inclusion of some oats, cottonseed meal, or linseed and cottonseed meal in the soybean oil meal ration resulted in a little faster and more efficient gains but did not overcome the deficiency of the ration. Neither 0.2 percent of the synthetic amino acid methionine nor 0.2 percent of the synthetic amino acid lysine improved the ration.

When yeast was grown in the wet feed or when adequate quantities of dried brewers' yeast, condensed fish solubles or dried distillers' grain solubles were included in the soybean oil meal ration the pigs grew normally, remained healthier and made appreciably more rapid and efficient gains than the pigs without them. Their performance compared favorably with that of pigs that received meat scraps or fish meal in the place of a part of the soybean oil meal. Yeast and dried distillers' grain solubles are rich in B complex or water soluble vitamins but are lacking in vitamin B_{12} (3) or what was originally known as the animal protein factor. Condensed fish solubles is rich in vitamin B_{12} as well as other B vitamins.

Dried distillers' grain solubles were also beneficial in a ration in which meat scraps replaced a part of the soybean oil meal so that each supplied approximately equivalent amounts of protein. In three experiments, the dried distillers' grain solubles lowered the feed required per 100 pounds of gain produced from 373 to 365 pounds or 2.1 percent. Presumably the benefit from the distillers' solubles was due to the B vitamins or the protein they contained or to both.

In April, 1948, E. L. Rickes and associates (10) of Merck and Company announced that they had isolated a red crystalline substance from liver which was effective against pernicious anemia. They tentatively designated it as vitamin B_{12}. Three months later E. Lester Smith and co-workers of Glaxo Laboratories in England (16) reported they had concentrated one gram of a crystalline red substance, which presumably was the same, from four tons of liver.

Various studies concerning vitamin B_{12} were made possible by its isolation. It prevented pernicious anemia in man (10). Its molecule was shown to contain phosphorus and cobalt (11, 17). And it was soon evident that if the new vitamin were not the animal protein factor it was at least a part of it. It was essential for the health and growth of pigs and chickens.

Vitamin B_{12} was found to be synthesized during fermentation caused by the growth of a number of microorganisms. In December, 1948, E. L. Rickes et al. (12) reported that certain microorganisms isolated from the soil, including several species of streptomyces one of

which was streptomyces griseus, produced vitamin B_{12} when they were grown in pure cultures. Streptomyces griseus is the organism which produces the antibiotic streptomycin.

At the Lederle Laboratories of the American Cyanamid Company, streptomyces aureofaciens, the organism which produces the antibiotic aureomycin, was found to be a good producer of vitamin B_{12}. Charles Pfizer and Company, Inc., found that the organism which produces terramycin likewise produces vitamin B_{12}. Other antibiotic producing microorganisms have been added and are being added to the list of those which produce vitamin B_{12}.

The slop or mash obtained from the production of a number of antibiotics is a source of vitamin B_{12} supplements now used for feeding purposes. Antibiotic supplements, B_{12} supplements and B_{12} and antibiotic supplements which contain designated amounts of each are produced. Although they were available for experimental feeding at an earlier date, vitamin B_{12} or B_{12} and antibiotic supplements were made available to the feed trade in the summer of 1949.

Vitamin B_{12} is needed in rations for poultry (7, 9) and pigs (1, 4, 5, 8, 18) but not in rations for ruminants. Microorganisms in the rumen of polygastric animals synthesize B_{12} and other B vitamins during the fermentative processes of digestion. The animals themselves do not manufacture B_{12}. Microorganisms utilize portions of the feed and the ruminants utilize the microorganisms or the products of their metabolism Hence, except possibly in the case of the young before rumination and synthesis has started or in the case of animals on rations unfavorable to synthesis ruminants are not likely to suffer from a deficiency of B_{12} or other B vitamins.

An interesting finding was that cow manure was an effective source of vitamin B_{12} (14). This explains why runty pigs often improve when placed with cattle and suggests that pigs may sometimes be provided with vitamin B_{12} by allowing them to follow cattle or giving them access to cattle manure.

Ruben, Bird, and Rothchild (15) found that the factor that was later shown to be B_{12} was present in hen droppings but that it was not available to the hens before the droppings were voided. McGinnis, Stevens and Groves (6) found that the factor was synthesized in hen feces by bacterial activity after the feces were voided and that there was a microorganism in hen feces that produced the factor.

Some synthesis of B vitamins, probably including B_{12} occurs in the intestinal tract of swine, particularly in older animals and under favor-

able conditions. Apparently absorption takes place too slowly or often the vitamins are not produced in young pigs in sufficient quantities for their optimum growth or well being.

EXPERIMENT 1

What was designated at the time as an APF concentrate was fed with corn, dried distillers' grain solubles, soybean oil meal, ground alfalfa, minerals, and irradiated yeast to pigs in a dry lot experiment started November 30, 1948. Fifteen pigs were used to the lot. They averaged 71 days of age and 49.0 pounds in weight at the start and were carried to a final weight of approximately 215 pounds.

The product used was furnished through the courtesy of Merck and Company. It contained charcoal as an adsorbate and had an activity equivalent to two milligrams of vitamin B_{12} to the pound. It constituted 0.4 percent of the ration and thus supplied 0.8 milligram of B_{12} per 100 pounds of total feed.

Table 1 shows the performance of groups of pigs without and with the product as well as that of a group fed meat scraps in the place of a

TABLE 1.—Feeding a B_{12} Supplement with a Soybean Oil Meal Ration to Pigs in Dry Lot

		1	2	3
Started Nov. 30, 1948. Fifteen pigs per lot. Pigs carried from approximately 49 to 215 pounds in weight. Feeds mixed and self fed.		Corn, dried distillers' grain solubles, soybean oil meal, ground alfalfa, minerals, and irradiated yeast		
			Meat scraps	**B_{12} supplement**
Average daily gain,	lb.	1.35	1.35	1.56
Days to gain 170 pounds		126	126	110
Daily feed per pig,	lb.	5.1	5.1	5.8
Feed per 100 pounds gain,	lb.	374.6	374.1	370.2
Cost of feed per 100 lb. gain		$13.49	$13.63	$14.01

PRICES USED: Ground shelled corn, 3.35; dried distillers' grain solubles, 5.0; meat scraps, 55 percent protein, 6.0; condensed buttermilk, 7.0; soybean oil meal, 44 percent protein, 4.8; ground alfalfa, 2.2; irradiated yeast, 40.0; iodized salt, 1.6; limestone, 1.0; special steamed bone meal, 5.25; ferrous sulfate, 5; cobaltous chloride, 178.0; Merck's B_{12} supplement, charcoal base, 50.0; Merck's B_{12} supplement, fullers' earth, 72.0; Aurofac, 45.0; Fortafeed, 66.0; Bi-Con T M5, 93.0; special B_{12} supplement, Pfizer's, 28.2; Merck's riboflavin mixture No. 54, 200.0; choline chloride mixture, 25 percent choline chloride, 23.0; niacin, 408.2; calcium pantothenate, 2,721.6 cents a pound; pyridoxine hydrochloride, 92.0 cents a gram; pasture 2 cents per pig per day.

part of the soybean oil meal so that each supplied approximately equivalent amounts of protein. The pigs given the material containing vitamin B_{12} ate 13.7 percent more feed daily a head, gained 15.6 percent more rapidly, were ready for market 16 days earlier and required 1.2 percent less feed per unit of gain than pigs given the same ration without it. There was practically no difference in the performance of the pigs without the vitamin B_{12} material and that of the pigs fed a mixture of meat scraps and soybean oil meal as a protein concentrate.

EXPERIMENT 2

A second experiment was started November 29, 1949. There were 13 pigs to the lot. They averaged 70 days of age and 45.0 pounds in weight at the beginning of the test. Each lot was continued until it reached an average final weight of approximately 210 pounds. Table 2 gives the results secured.

In this experiment pigs fed the same basal ration as was used in the previous test gained 1.21 pounds daily a head and required 383.0 pounds of feed per 100 pounds of gain. Two of the pigs which gained satisfactorily at first did poorly later and were removed. A mild

TABLE 2.—Feeding Meat Scraps, a B_{12} Supplement and a B_{12} and Antibiotic Supplement with a Soybean Oil Meal Ration to Pigs in Dry Lot

		1	2	3	4	5
Started Nov. 29, 1949. Thirteen pigs per lot. Pigs carried from approximately 45 to 210 pounds in weight. Feeds mixed and self fed.		Corn, dried distillers' grain solubles, soybean oil meal, ground alfalfa, minerals, and irradiated yeast				
			Meat scraps	**B_{12} supplement***	**B_{12} supplement**	**B_{12} and antibiotic supplement**
Average daily gain,	lb	1.21	1.39	1.48	1.57	1.70
Days to gain 170 pounds		141	123	115	109	100
Daily feed per pig,	lb.	4.6	5.0	5.5	5.8	6.0
Feed per 100 lb. gain,	lb.	383.0	366.7	369.4	367.8	351.2
Cost of feed per 100 pounds of gain		$13.82	$13.38	$13.39	$13.51	$13.25

*With dried distillers' grain solubles omitted from the ration.

infection may have temporarily retarded some of the others in the lot. In seven other tests a total of 96 pigs on the same ration gained 1.34 pounds daily a head and required 373.6 pounds of feed per 100 pounds of gain.

A material which was furnished through the courtesy of Merck and Company and which contained fullers' earth as an adsorbate was added to the basal ration for one lot of pigs at a rate which supplied 1.25 milligrams of vitamin B_{12} per 100 pounds of total feed. The pigs that received it gained 1.57 pounds daily a head and required 367.8 pounds of feed per 100 pounds of gain. They ate 15.4 percent more feed daily a head, gained 17.3 percent more rapidly, were ready for market 18 days earlier and required 1.5 percent less feed per 100 pounds of gain than those in the seven tests mentioned that received the same ration without the addition of a vitamin B_{12} supplement.

As against the average daily gain of 1.34 pounds and the average feed requirement per 100 pounds of gain of 373.6 pounds for pigs fed dried distillers' grain solubles but no B_{12} supplement, a group without distillers' solubles but fed the material containing vitamin B_{12} and having fullers' earth as an adsorbate gained 1.48 pounds daily and required 369.4 pounds of feed per 100 pounds of gain. The material supplying vitamin B_{12} was more effective for feeding with corn, soybean oil meal, ground alfalfa, minerals, and irradiated yeast to pigs in dry lot than was dried distillers' grain solubles but the two together were more effective than was either alone.

A group of pigs fed meat scraps in the place of a part of the soybean oil meal so that each supplied approximately equivalent amounts of protein made as much gain per unit of feed consumed but gained 11.5 percent less rapidly and were not ready for market until 14 days later than those fed the vitamin B_{12} supplement but not meat scraps.

In the experiment one group of pigs having a soybean oil meal ration containing dried distillers' grain solubles was fed a different APF concentrate or vitamin B_{12} supplement. It was derived from the production of the antibiotic aureomycin and was manufactured by and furnished through the courtesy of the Lederle Laboratories Division of the American Cyanamid Company. It was fed at the rate of 0.4 of a percent which, according to the manufacturers, would supply 0.5 to 0.7 of a milligram of vitamin B_{12} per 100 pounds of total feed.

The pigs having the second B_{12} supplement gained 8.3 percent more rapidly, were ready for market 9 days earlier and required 4.5 percent

less feed per 100 pounds of gain produced than pigs having the other B_{12} supplement in a similar ration. It is now known that the additional response from the second material was due to the residues of the antibiotic, aureomycin, it contained.

EXPERIMENT 3

The effect of feeding a B_{12} supplement with corn, soybean oil meal, ground alfalfa, minerals, irradiated yeast, crystalline aureomycin and the B vitamins riboflavin, calcium pantothenate, niacin, and choline chloride and with a similar ration having fish meal, or an animal protein concentrate substituted for a part of the soybean oil meal so that each supplied approximately equivalent amounts of protein is shown in Table 3.

Crystalline aureomycin for the experiment was furnished through the courtesy of the Lederle Laboratories Division of the American Cyanamid Company. A special B_{12} supplement was prepared and furnished through the courtesy of Charles Pfizer and Company, Inc. It contained 4.9 milligrams of B_{12} activity to the pound. The other B vitamins or materials containing them were furnished through the courtesy of Merck and Company, Inc.

Pre-mixes of soybean oil meal, the antibiotic and the B vitamins were made so that when 0.4 of a percent was included in the rations the following milligrams were supplied in each 100 pounds of total feed: crystalline aureomycin, 500; riboflavin, 300; calcium pantothenate, 1000; niacin, 1350; and choline chloride, 1500. The B_{12} supplement when used was included in the pre-mix at a rate which supplied one milligram of B_{12} in each 100 pounds of total feed.

The pigs averaged 68 days of age at the start of the experiment. Previous to the beginning of the experiment they received a ration which containd a B_{12} and antibiotic, aureomycin, supplement and a concentrate which supplied riboflavin, calcium pantothenate, niacin, and choline chloride.

The pigs on the soybean oil meal ration with the B_{12} supplement gained 2.0 percent more rapidly and required 1.0 percent less feed per 100 pounds of gain than those on the same ration without it. These differences are negligible. During the growing period or from approximately 50 to 120 pounds in weight the pigs with the B_{12} supplement gained 4.0 percent more rapidly and required 6.4 percent less feed per 100 pounds of gain than those without it. During the fattening period or from approximately 120 pounds on they gained only 0.6 percent more

TABLE 3.—Feeding a B_{12} Supplement with a Soybean Oil Meal Ration and with One Containing Fish Meal to Pigs in Dry Lot

		1	2	3	4
Started Nov. 28, 1950. Fourteen pigs per lot. Pigs carried from approximately 50 to 220 pounds in weight Feeds mixed and self fed		Corn, B vitamins concentrate, soybean oil meal, ground alfalfa, minerals, crystalline aureomycin, and irradiated yeast			
			B_{12} supplement	**Fish meal**	**Fish meal and B_{12} supplement**
Average daily gain,	lb.	1 72	1 76	1 86	1 86
Days to gain 170 pounds		99	97	92	92
Daily feed per pig,	lb	6 2	6 3	6 6	6 7
Feed per 100 pounds gain,	lb	362 3	358 7	352 9	363 7
Cost of feed per 100 pounds of gain		$13 61	$13 62	$13 46	$14 05

rapidly and, instead of less, required 2.3 percent more feed per 100 pounds of gain produced than the pigs without the B_{12} supplement. The B_{12} supplement was helpful when the pigs were young but was of little or no benefit when they were older.

Nothing was gained from feeding a B_{12} supplement with a ration which contained 7.8 and 5.8 percent of fish meal during the growing period and the fattening period, respectively. For some reason the pigs given a B_{12} supplement with a high-protein feed of soybean oil meal and fish meal required 3.7 and 3.5 percent more feed per 100 pounds of gain during the growing and during the fattening periods, respectively, than pigs on the same ration without the B_{12} supplement. They gained 3.5 percent more and 3.4 percent less rapidly during the growing and during the fattening period, respectively, than the pigs without the B_{12} supplement.

EXPERIMENT 4

Another experiment in which a vitamin B_{12} supplement was added to a soybean oil meal or plant protein ration for pigs in dry lot was started June 12, 1951. It is reported in Table 4. Twelve pigs were used to the lot. Those in each lot were carried from 41 to approximately 220 pounds in weight. Previous to the beginning of the experiment the pigs received a B_{12} and antibiotic, aureomycin, supplement and a B vitamins concentrate which supplied riboflavin, calcium pantothenate, niacin, choline chloride, and folic acid.

Five percent of dried distillers' grain solubles and five percent of ground alfalfa were included in the basal ration. The other ingredients were corn, soybean oil meal, minerals, and irradiated yeast. The minerals contained a tenth of a percent of cobaltous chloride, $CoCl_2.6H_20$. The B_{12} supplement was furnished through the courtesy of Merck and Company, Inc. It was fed at a level of 0.08 percent, which supplied one milligram of vitamin B_{12} per 100 pounds of total feed.

There was practically no difference in the performance of the pigs with and the pigs without the B_{12} supplement. For the entire time those with it required 1.2 percent less feed per 100 pounds of gain and gained no faster than those without it. Until they reached a weight of 120 pounds, the pigs with it gained 3.9 percent less rapidly and required 1.1 percent more feed per 100 pounds of gain than those without it. For the remainder of the experiment they gained 1.4 percent more rapidly

TABLE 4.—Dried Distillers' Grain Solubles and a B_{12} Supplement Compared with Condensed Buttermilk for Feeding with a Soybean Oil Meal Ration to Pigs in Dry Lot

		1	2	3	4	5
Started June 12, 1951. Twelve pigs per lot. Pigs carried from approximately 41 to 220 pounds in weight. Feeds mixed and self fed †		Corn, soybean oil meal, ground alfalfa, minerals, and irradiated yeast				
		Condensed buttermilk	**Dried distillers' solubles**	**Dried distillers' solubles B_{12}**	**Dried distillers' solubles B_{12} Antibiotic**	**Meat scraps Dried distillers' solubles B_{12} Antibiotic**
Average daily gain,	lb.	1.58	1.63	1.61	1.73	1.67
Days to gain 170 pounds		117	111	112	105	108
Daily feed per pig,	lb.	5.48*	6.06	5.93	6.24	6.04
Feed per 100 lb. gain,	lb.	354.8*	372.0	367.5	361.0	362.2
Cost of feed per 100 pounds of gain		$15.94	$13.41	$13.45	$13.53	$13.71

*With condensed buttermilk reduced from 73 to a moisture basis of 10 percent.
†Condensed buttermilk fed separately.

and required 3.1 percent less feed per 100 pounds of gain than those without it.

One group of pigs was self fed a mixture of corn, soybean oil meal, ground alfalfa, minerals, and irradiated yeast and was given an average of approximately a pound of condensed buttermilk daily a head as a drink. At the rate fed the condensed buttermilk supplied a little over half as much protein as the soybean oil meal.

The condensed buttermilk contained 73 percent of moisture. Although with it figured on a basis of 10 percent of moisture, the pigs that received it required 4.6 percent less feed per 100 pounds of gain produced, they gained less rapidly, and did not reach a weight of 220 pounds until six days later than those that received a similar ration except that it contained dried distillers' grain solubles but no condensed buttermilk.

At the prices used, in order for the pigs that received the condensed buttermilk to have made as economical gains as those that received the dried distillers' grain solubles, the condensed buttermilk would have needed to be purchased at 2.73 cents a pound. It cost 7.0 cents a pound.

The pigs given the B_{12} supplement with the ration containing dried distillers' grain solubles, ate 5.0 percent less feed daily a head, gained 6.9 percent less rapidly, reached a given market weight 7 days later, and required 1.8 percent more feed per unit of gain than pigs given both a B_{12} and an antibiotic, aureomycin, supplement with the same ration. Vitamin B_{12} was fed at the rate of one milligram per 100 pounds of feed. The antibiotic supplement was fed at a rate which supplied 0.5 gram of aureomycin per 100 pounds of feed.

Pigs given both a B_{12} and an antibiotic supplement and fed a similar ration except that meat scraps replaced a part of the soybean oil meal so that each supplied equivalent amounts of protein made no faster gains and no greater gains per unit of feed consumed than the pigs without the meat scraps.

EXPERIMENT 5

A fifth experiment in which a B_{12} supplement was fed to pigs in dry lot was started November 27, 1951. There were 15 pigs to the lot. They averaged 63 days of age at the start. Each lot was carried from 45 to approximately 210 pounds in weight. Before weaning and from weaning until the start of the experiment they were fed a ration that contained a B vitamins concentrate and a B_{12} and antibiotic supplement.

During the experiment one group was given cobalt in their minerals but no B_{12} supplement. Another was given a B_{12} supplement but no cobalt. A third received both cobalt and a B_{12} supplement. The basal ration was one of corn, soybean oil meal, ground alfalfa, minerals, irradiated yeast, crystalline aureomycin and a B vitamins concentrate. The mineral mixture for the second group consisted of iodized salt, 19.2; pulverized limestone, 38.4; special steamed bone meal, 38.4; powdered ferrous sulfate, 4.0. That for the other two was similar except that 0.1 pound of ferrous sulfate was replaced with an equal amount of cobaltous chloride, $CoCl_2.6H_2O$. The B vitamins concentrate was Fortafeed to which pyridoxine hydrochloride was added at the rate of 0.5 of a gram to the pound.

Crystalline aureomycin and Fortafeed for the experiment were furnished through the courtesy of the Lederle Laboratories Division of the American Cyanamid Company. The pyridoxine hydrochloride and the B_{12} supplement were furnished through the courtesy of Merck ahd Company, Inc.

When tne B_{12} supplement was fed it was used at a rate which supplied one milligram of B_{12} per 100 pounds of total feed. The percentage of concentrate used supplied the following milligrams of B vitamins per 100 pounds of total feed: riboflavin, 300; calcium pantothenate, 600; niacin, 1350; choline chloride, 1500; folic acid, 9; and pyridoxine, 75.

Table 5 shows the results secured. Until the pigs averaged 125 pounds in weight those given a B_{12} supplement gained 5.9 percent faster and required 6.4 percent less feed per 100 pounds of gain than those on the same ration without it. From approximately 125 to 210 pounds in weight, feeding a B_{12} supplement was of no benefit.

The performance of the pigs given a B_{12} supplement but no cobalt was practically the same as that of the pigs given a B_{12} supplement and cobalt. In soybean oil meal rations in other experiments without a B_{12} supplement, cobalt reduced the amount of feed required per unit of gain. In this experiment, with a B_{12} supplement, the cobalt gave practically no additional response. On the other hand, when cobalt was included in the minerals, nothing was gained from feeding a B_{12} supplement after the pigs reached a weight of 125 pounds.

TABLE 5.—Feeding a B_{12} Supplement in a Soybean Oil Meal Ration Without and With Cobalt in the Minerals

		1	2	3
Started Nov. 27, 1951. Fifteen pigs per lot. Pigs carried from approximately 45 to 210 pounds in weight. Feeds mixed and self fed.		Corn, B vitamins concentrate, soybean oil meal, ground alfalfa, minerals, crystalline aureomycin, and irradiated yeast		
		Cobalt	**B_{12} supplement**	**Cobalt and B_{12} supplement**
Average daily gain,	lb.	1.62	1.71	1.68
Days to gain 170 pounds		105	100	102
Daily feed per pig,	lb.	5.68	5.89	5.76
Feed per 100 pounds gain,	lb	350.7	345.4	343.7
Cost of feed per 100 lb. gain		$13.08	$13.04	$12.99

EXPERIMENT 6

A pasture experiment in which rations without and with a B_{12} supplement added were compared was started May 22, 1951. The pasture was a mixture of alfalfa and timothy with a very small amount of Ladino clover in it. About three weeks after the start of the test the pasture was mowed and the resulting hay was removed. The plots contained 1.25 acres. There were 20 pigs to the lot. They averaged 56 days of age at the start and were carried from 32 to approximately 220 pounds in weight. During the suckling period they had been creep fed a ration which contained a B_{12} and antibiotic supplement and a B vitamins concentrate.

The experimental rations were composed of ground shelled corn, a protein concentrate, minerals, and an antobiotic supplement which supplied 0.5 gram of terramycin to each 100 pounds of total feed. The antibiotic, terramycin, supplement was furnished through the courtesy of Charles Pfizer and Company, Inc. The protein concentrate consisted of 55 percent protein meat scraps and 44 percent protein soybean oil meal in a 1:2 ratio. A tenth of a percent of cobaltous chloride, $CoCl_2.6H_2O$, was included in the mineral mixture. Before and after the pigs reached a weight of approximately 120 pounds the rations were made up to contain approximately 14 and 12 percent of protein, respectively.

There was a negligible difference in the feed consumed daily per head, in the rapidity of the gains, and in earliness of marketing but no difference in the amount of feed required per unit of gain in favor of the pigs with over those without a B_{12} supplement in their ration.

VITAMIN B_{12} FOR YOUNG AND FOR OLDER PIGS

Should a vitamin B_{12} supplement be fed to older as well as to young pigs?

In the Ohio experiments the pigs ranged from 8 to 10 weeks in age and from 41 to 49 pounds in weight at the start. In an eleven-week Michigan trial (5) a basal ration of corn, soybean oil meal, minerals, a vitamin A and D supplement and liberal amounts of thiamine, riboflavin, calcium pantothenate, niacin, and pyridoxine was fed to two groups of 7 pigs each, averaging 26 pounds in weight at the start. The pigs were from gilts which had received no feed known to be a source of vitamin B_{12}. A B_{12} supplement increased the rapidity of the gains 53 percent and lowered the feed required per unit of gain 8.3 percent.

In a second Michigan trial (5) of six weeks duration, with nine 26-pound pigs to the lot, a B_{12} supplement resulted in 77 percent faster gains and in a saving in feed per unit of gain of 12 percent. The pigs in the second test were from gilts which had been on pasture and which had received a high protein feed of animal origin.

TABLE 6.—A B_{12} Supplement with Corn and a Protein, Mineral, and Antibiotic Supplement for Pigs on Mixed Pasture

		1	2
Started May 22, 1951. Twenty pigs per lot. Pigs carried from approximately 32 to 200 pounds in weight. Feeds mixed and self fed.		Corn, protein concentrate, minerals, and antibiotic supplement	
			B_{12} supplement
Average daily gain,	lb.	1.62	1.67
Days to gain 170 pounds		118	114
Daily feed per pig,	lb.	5.6	5.8
Feed per 100 pounds gain,	lb.	348.2	348.4
Cost of feed per 100 pounds of gain		$13.00	$13.21
Cost of feed and pasture per 100 pounds of gain		$14.23	$14.41

Protein Concentrate=Meat scraps, 55 percent protein, and toasted solvent extracted soybean oil meal, 44 percent protein, in a 1:2 ratio.

In a Texas trial (1) with young pigs, those given a B_{12} supplement gained 31 percent more rapidly and required 22.7 percent less feed per 100 pounds of gain than those given no B_{12} supplement. A basal ration of corn, soybean oil meal, alfalfa leaf meal, limestone, and salt was fed.

During the growing period (or from approximately 46 to 120 pounds in weight) in the five Ohio dry lot comparisons discussed, a B_{12} supplement increased the daily feed consumption 8.3 percent, increased the rapidity of the gains 13.7 percent, and decreased the amount of feed required per unit of gain 4.7 percent.

During the fattening period or from approximately 120 to 215 pounds in weight, a B_{12} supplement increased the daily feed consumption 4.7 and the rapidity of the gains 4.9 percent but brought about 0.26 of a percent, or virtually no reduction in the amount of feed required per 100 pounds of gain produced. The rations were composed of yellow corn, soybean oil meal, ground alfalfa, minerals, irradiated yeast, and dried distillers' grain solubles or a B vitamins concentrate. The basal rations contained an antibiotic in 2 and a mineral mixture supplying cobalt in 2 of the comparisons. Those without and those with a B_{12} supplement included were fed to totals of 69 and 68 pigs, respectively. At the prices used for the various ingredients in the rations, a B_{12} supplement decreased the cost of feed per 100 pounds of gain 26 cents before and increased it 26 cents after the pigs averaged 120 pounds in weight.

SUMMARY

In five dry lot experiments with pigs carried from averages of 46 to 213 pounds in weight on soybean oil meal rations, those given a B_{12} supplement ate 7.8 percent more feed daily a head, gained 9.2 percent more rapidly, were ready for market ten days earlier, and required 1.3 percent less feed per 100 pounds of gain than those without it. Either dried distillers' grain solubles, which is rich in other B vitamins, or a B vitamins concentrate, was included in the rations. An antibiotic was fed in one, cobalt in one, and both were fed in another of the five experiments.

A vitamin B_{12} supplement was more effective for feeding with corn, soybean oil meal, ground alfalfa, minerals, and irradiated yeast to pigs in dry lot than was dried distillers' grain solubles. However, the two together were more effective than either alone.

With no cobalt in the minerals the pigs given a B_{12} supplement required 1.8 percent less feed per unit of gain, ate 13.2 percent more feed daily a head and gained 15.2 percent more rapidly than the pigs without it.

With cobalt in the minerals the pigs given a B_{12} supplement required 0.7 percent less feed per unit of gain but ate no more feed and gained no faster than the pigs without it.

When no antibiotic was fed, the pigs given a B_{12} supplement ate 12.1 percent more feed daily a head, gained 13.5 percent more rapidly, and required 1.2 percent less feed per unit of gain than the pigs without it.

When an antibiotic was fed the pigs given a B_{12} supplement ate 1.4 percent more feed daily a head, gained 2.9 percent more rapidly, and required 1.4 percent less feed per unit of gain.

The response from feeding a B_{12} supplement with soybean oil meal rations to pigs in dry lot was greatest while the pigs were young and decreased as they became older. At the prices used, a B_{12} supplement decreased the cost of the gains before but increased the cost of the gains after the pigs averaged 120 pounds in weight.

Pigs in dry lot fed corn, dried distillers' grain solubles, soybean oil meal, ground alfalfa, minerals, irradiated yeast, and a B_{12} supplement gained 6.5 percent faster and required 0.7 percent more feed per unit of gain than pigs having no B_{12} supplement but having meat scraps in the place of a part of the soybean oil meal so that each supplied equivalent amounts of protein.

Pigs having both a B_{12} supplement and meat scraps with a ration of the same type except that it contained an antibiotic supplement gained 3.5 percent less rapidly, were ready for market 3 days later, and required 0.3 of a percent more feed per unit of gain than pigs having only soybean oil meal as a protein concentrate. The pigs without did as well as those with meat scraps.

Pigs fed dried distillers' grain solubles and a B_{12} and antibiotic supplement with corn, soybean oil meal, ground alfalfa, minerals, and irradiated yeast required 1.7 percent more feed per unit of gain but gained 9.5 percent more rapidly, were ready for market 12 days earlier, and made more economical gains than pigs fed approximately a pound of condensed buttermilk daily per head with an otherwise similar ration.

By the end of the experiment, or the time at which the pigs reached a weight of 220 pounds, there was no benefit from including a B_{12} supplement in a dry lot ration which contained 7.8 and 5.8 percent of fish meal before and after the pigs averaged 120 pounds in weight, respectively. From 50 to 120 pounds in weight the pigs with and those without the B_{12} supplement gained 1.79 and 1.73 pounds daily and required 306 and 295 pounds of feed per 100 pounds of gain, respectively. Crystalline aureomycin was fed at the rate of 0.5 gram per 100 pounds of feed.

Feeding a B_{12} supplement with corn, minerals, an antibiotic, terramycin, supplement and a protein concentrate of meat scraps and soybean oil meal in a 1:2 ratio to pigs on pasture resulted in a negligible increase in the rate of gain and in no increase in the amount of gain per unit of feed consumed. The minerals contained cobalt.

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